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BUTTER SUBSTITUTES.

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MANUFACTURE AND SALE OF OLEOMARGARINE.

In 1869 Mege Mouries, at the instigation of the French Government, undertook experiments for the purpose of securing a substitute for butter which could be produced at less cost and might be used by the navy and by the poorer classes of citizens. This original process was patented in the United States in 1873. Without giving Mege Mouries's patent in detail, the principal points were the preparation of margarine oil by the artificial digestion of the fat taken from animals and the separation of the stearin, which melts at a high temperature, by pressure. This so-called liquid margarine was then churned into milk, finely divided cow's udder and carbonate of sodium being used to facilitate the emulsion. The result was a product which when salted and colored resembled butter in appearance, taste, and general properties. Many modifications of this process were at once suggested, the object being to utilize as much as possible surplus animal fats. For this purpose numerous improvements were patented for purifying these fats by fermentation and by the subsequent use of chemicals.

The process as at present used, however, is comparatively simple. The oleo oil and "neutral" lard are mixed together, either alone or with the addition of cotton-seed oil or milk and butter, in steam-jacketed vessels provided with paddles, the resulting product being called oleomargarine or butterine, according to the quantity of butter used. The manufacture is a simple one, and the questions of importance are the character of the fats used and the cleanliness in the preparation of the oleomargarine.

The two especial points originally claimed for the oleomargarine were, that by a judicious admixture of stearin the product would retain its consistency, even in hot weather, and that it could be readily transported and preserved for a long time without becoming rancid. For cooking purposes the oleomargarine should be quite useful, as it

presented by the author

is simply the mixture of the natural animal fat in such proportions as to produce a compound having the consistency of butter; but for eating in place of butter—an article of food which is made more palatable and digestible by its particular aroma and flavor—the results are different. This fact was recognized and acknowledged as soon as its use was begun. As the oleomargarine could be made very much more cheaply than butter, fraud was at once inaugurated by selling the product as pure butter. The development of this traffic was not in response to a public demand, but the product was brought to the public under the guise of genuine butter, so that a continuous fraud was perpetrated. The enormous abuses in this traffic led to the adoption of very stringent laws, on the part of many States, with reference to the manufacture and sale of oleomargarine. On this account its manufacture is at present confined to eight States, there being, according to the report of the Commissioner of Internal Revenue, August 10, 1895, five factories in Illinois, two in Indiana, three in Kansas City, Mo., and Kans., one in Nebraska, one in Ohio, one in Pennsylvania, and four in Rhode Island.

In the year 1883, 45,000,000 pounds of oleomargarine were sold in the United States, and in spite of restrictive legislation the manufacture has slowly increased; in 1894, 69,622,246 pounds were manufactured, against 67,224,298 pounds in 1893, an increase of 2,397,948 pounds. The amount withdrawn for export for the fiscal year 1893 was 2,785,494 pounds, and for 1894, 3,406,683 pounds, showing a slight increase in the export trade, but not proportional to the increased manufacture.

MATERIAL USED FOR MANUFACTURE.

In the Eastern States the larger part of the oleo oil and lard used in the manufacture is purchased, while in the Western factories the materials used are prepared directly in the oleomargarine factories. To prepare oleo oil, the chief product, the selected and ground animal fats, are melted in kettles at as near 150° F. as possible, and the fiber allowed to settle out. The melted fat is then run into chilling vats, where it is cooled until most of the stearin has crystallized. The mixture is then thoroughly pressed, the olein, together with a little stearin and palmitin, constituting the oleo oil, while the remaining press cake, consisting of stearin, is used in the manufacture of soap, candles, compound lard, etc. The amount of pressure used in separating the stearin is varied at times, leaving a greater or less quantity of stearin in the oleo oil.

The fat which is used especially for preparing the oleo oil is that cut from the kidneys and intestines. In the large packing houses, where the manufacture of the oleomargarine is carefully conducted, only the best selected fats are used. As a matter of fact, only clean, fresh fat can be utilized in preparing a really good product. In the

smaller factories, however, which are devoted to the manufacture of oleomargarine alone, the oleo oil is rendered from the scraps of the abattoirs, butcher shops, and sometimes from hotel waste. These scraps necessarily include not only the fat of beeves, but of sheep, hogs, chickens, etc.—anything, in fact, which may find its way into the butcher shops. The fat scraps when brought to the factory are first carefully sorted, and washed in large vats. Pieces that have a slightly tainted odor are thrown out, to be used for the manufacture of tallow or for the soap makers. The good pieces are then cut up and ground and used for the preparation of the oleo oil.

The lard used for oleomargarine is usually good leaf lard. The cotton-seed oil used in the manufacture of oleomargarine is probably the most healthful of all its constituents, as generally a good quality is selected.

The proportions in which the oleo oil lard and cotton-seed oil are mixed vary with the season of the year and the character of the products desired. Some manufacturers do not use cotton-seed oil. For the manufacture of butterine, butter, usually of a very good grade, is churned in with the oleo and lard to secure the flavor, while the desired color is obtained by the addition of annatto and turmeric. The oleomargarine proper is made without butter, and is colored to suit the requirements of the trade. The export trade seems to demand a very highly colored product; a brand of a tomato color is in high favor in the West Indies and Central America.

HYGIENIC EFFECTS OF OLEOMARGARINE.

The important points in connection with oleomargarine are its hygienic effects as compared with butter. First, as to its digestibility. Very few careful and systematic experiments as to the actual digestibility by man of oleomargarine as compared with butter have ever been made. Mayer, a German chemist, reports two series of experiments conducted, one upon a man, the other upon a boy, which showed the digestibility of oleomargarine to be about 2 per cent less than that of butter. A number of prominent chemists have placed themselves on record as holding that oleomargarine, if properly and carefully made from good, fresh fat, was quite as healthy and digestible as butter. With the exception of the experiments reported, none of these gentlemen, however, had made any practical tests as to the digestibility of these fats, but based their opinions entirely upon theoretical considerations.

Within the last few years the process of manufacture has changed considerably, so that the results as to digestibility would now differ materially from those of the early experiments. All the statements in regard to its use, however, are qualified with the proviso that these products are good if made from fresh and healthy material.

Sell, the authority on foods for the German Government, says:

Apart from a somewhat less digestibility, the artificial butter prepared from the fat of healthy animals furnishes in general no reason to suppose that it can affect the health injuriously. There is good ground, however, to believe that a part of the artificial butter is manufactured from fat of diseased animals, or dead animals, and often from material that will have to be deodorized.

A committee of the Academy of Medicine in Paris, in 1880, after studying the subject, declared that oleomargarine was not as digestible as butter, on account of the larger amount of stearin and palmitin, but, unfortunately, they did not give the experiments leading to these conclusions.

To establish some data in this connection, A. Jolles, of Vienna, has recently conducted an experiment upon a dog, feeding the animal during two periods of eight days each with the best butter, and during two other periods of eight days each with oleomargarine, together with sugar, wheat meal, and salt. The analysis of the butter showed—

	Per cent.
Water	10.24
Casein	.63
Milk sugar	.54
Salts	.34
Fat by difference	88.25
Total	100.00
Reichert No. 28.6.	

The analysis of the oleomargarine showed—

Iodine No.	47.0
Melting point fatty acid	42.6° C.
Solidification point	39.5° C.
Saponification equivalent	197.5

The butter was obtained from a Vienna dairy and very carefully made. The oleomargarine was also from a specially prepared lot made by the Vienna Margarine Company. The experiment was carefully conducted. Exact analyses of the constituents of the food used were made, the quantity consumed carefully weighed and the excreta also carefully weighed and analyzed, so as to show the quantity and character of the material actually absorbed. From these data the results were calculated, and the conclusion drawn that under exactly the same conditions the oleomargarine, if perfectly pure, was quite as digestible as the butter. The quality of perfect purity, however, and a sample of the same character as that used by Jolles would be difficult to obtain, certainly can not be found in our markets, if the samples we have examined serve for good comparison. And, it may be added fats which are equally digestible, and which would not affect digestion in the dog, might show an important difference when taken into the

stomachs of people whose digestion under most favorable conditions is not satisfactory.

As fat is one of the most important factors in the production of animal heat, the heat of combustion of butter and oleomargarine should throw some light on their relative value. The calories of 1 gram of butter fat are about 300 less than of 1 gram of oleomargarine, showing that more heat is given by the oleomargarine. This also indicates, however, a more complex fat molecule, and probably less digestibility for the oleomargarine.

There are a number of interesting cases where dissatisfaction can be traced to the use of oleomargarine. This product was furnished to the inmates of a certain blind asylum without their knowing its character. They ate less and less every day, and finally altogether refused to use it, saying that it was undesirable. This was the natural rebellion on the part of the digestive organs to the use of a mixture of fats which was not adapted for the purpose to which it was applied. While recently engaged in an examination of samples of oleomargarine, an employee of the Bureau biochemic laboratory undertook to substitute a good brand of oleomargarine for butter at his meals. After a few days he claimed that this had caused indigestion, and he would not use it any longer.

Without entering upon a discussion of the process of digestion in the animal body, the action of the pancreatin appears to be most important in the emulsification of fats. An artificial digestion, imitating as nearly as possible the conditions obtaining in man, shows that butter is far better emulsified than either cotton-seed oil, oleomargarine, or suet, and consequently more rapidly digested. The undesirability of oleomargarine is proved again by the fact that in hotels, boarding schools, and public institutions where oleomargarine and butterine are furnished instead of butter there is less used.

POSSIBILITY OF TRANSMITTING INFECTIOUS DISEASES.

The point next to be considered is the possibility of the transmission of infectious diseases by oleomargarine made from impure materials. That such can occur is undoubtedly true. A comparison of the germs present in oleomargarine and butter showed three times as many in the one as in the other, with a difference in the character of the germs. The germs in the butter were the harmless ones found in milk and necessary for the production of a good butter. Those in the oleomargarine were fungi and numerous varieties of bacteria.

The writer has made a number of inoculation experiments upon guinea pigs with different samples of oleomargarine. The samples were purchased in open market, near the places where they were manufactured. Sample No. 3 (102) proved fatal, causing the death of the animal in the one instance in two months; in the other, in two weeks. An examination showed the lungs congested, the liver soft

and pale, one of the kidneys badly congested, and five distinct ulcers in the intestines, like typhoid-fever ulcers. The bladder was distended and urine albuminous. At the present writing the nature of this disease has not been determined, but the fatal effects were produced by the oleomargarine. Another guinea pig inoculated with a sample (No. 1) of oleo oil, taken from a lot used in the manufacture of oleomargarine, died within three weeks, the autopsy showing badly congested lungs, liver dark, blood vessels congested, and the small intestines containing bloody mucus.

Five months after inoculation with another sample (No. 6 I) (105) of oleomargarine the pig which had been used for the experiment was chloroformed for examination. The animal was in fair condition, but the left lung showed incipient tuberculosis, and this disease was also apparent in the spleen, and there were several calcareous tubercular nodules adherent to the sternum. A preparation made from this same sample had shown the presence of a germ which could scarcely be anything but the tuberculosis bacillus. The result of the inoculation confirmed this diagnosis. The inoculations of all the animals were made by introducing in the side a bit of fat the size of a small pea. The incision healed rapidly, and at the time of the autopsies there was no evidence of local lesions or any effect which might have been due directly to the mechanical part of the inoculations.¹

A number of other guinea pigs have been inoculated with different samples of oleomargarine, but at this writing (after eight months) have not contracted disease from the oleomargarine inoculation. Two of the samples which caused disease in the animals were made at a factory where the material used may have been questionable in character.

Our inoculation experiments show conclusively that disease may be communicated by means of oleomargarine. The objection might be raised that disease could also be communicated in the same way by butter. It is, however, a very simple and easy matter to pasteurize the cream before churning, and use some of the known good butter-flavoring bacteria to develop the aroma; or it might be possible also to flavor the butter with the volatile acids and ethers which the bacteria produce. In this way butter can be easily made which is perfectly harmless, even supposing, what has not been proved in this country, that good butter could serve as a source of disease. The temperature of pasteurization is, however, unfavorable for oleo-oil manufacture.

Another point often urged in favor of oleomargarine is that it will keep longer than butter without becoming rancid. Of course, tallow,

¹Two other animals that had been inoculated with oleomargarine (No. 4 I and No. 2 III) (103 and 107) were also found dead. One showed evidences of incipient tuberculosis; the other, digestive derangement.

stearin, and lard will keep longer than butter without spoiling, but there is no object in using plain oleomargarine, as one might as well at once spread stearin and lard on the bread. Butterine which contains a considerable amount of butter will become rancid almost as readily as butter. Good butter, if carefully made and well washed, will keep satisfactorily.

The statements of most authorities have been to the effect that oleomargarine is good and digestible and healthful, provided it is made from pure material and the process is properly conducted. The legitimate and safe manufacture of oleomargarine can be secured, therefore, only when there is careful and safe control and inspection at the abattoirs and oleomargarine factories of both the finished product and the constituents which enter into its manufacture. Then, too, all the oleomargarine should be sold as oleomargarine, and should have something distinctive about its appearance—absence of color, as Massachusetts demands, or a specially bright color; and every pound of it should be carefully inspected at the factories before being shipped, to see that the particular distinctive character is present.

FRAUDULENT SALE OF OLEOMARGARINE.

Another frequent and serious objection that can be used against oleomargarine is the fact that its sale is usually fraudulent, as the article is not sold under its true name. Recently several butter samples were purchased in the open market of Washington City, by a butter dealer, as the best varieties of butter that could be obtained, and submitted to this laboratory for examination. Only one of these was found to be butter.

In some of the States the laws are very stringent against the fraudulent sale of oleomargarine, and heavy penalties are provided for its evasion. In Massachusetts it is against the law to sell oleomargarine which has been colored. This lack of color renders it possible, as a rule, to distinguish between oleomargarine and butter. In Pennsylvania the law forbids the sale within the State of oleomargarine manufactured in the State, but that manufactured outside of the State can be sold within its borders. In spite of this restrictive legislation, however, the production of oleomargarine, as shown by the figures before quoted, is steadily increasing.

To show the comparative composition of oleomargarine of various sources and good butter, the following table is given:

Analyses of oleomargarines, butterines, and butters (by James A. Emery).

OLEOMARGARINES AND BUTTERINES.

Serial number.	Water.	Casein (albuminoid).	Ash.	Salt.	Volatile fat acids (No. cc. $\frac{n}{10}$ Ba(OH) ₂ to 2.5 gr.).	Iodine number.	Specific gravity.	Melting point.	Combustion (calories, per gram).	Cotton-seed oil.
								° C.		
100	8.09	1.46	4.24	4.02	0.30	62.19	0.8916	-----	-----	
101	9.68	1.43	4.68	2.30	.17	63.52	.8638	-----	-----	
102	10.96	1.56	6.01	6.60	.25	66.69	.8667	-----	-----	
103	9.32	.07	-----	4.80	.15	61.44	.8913	-----	-----	
104	9.40	4.83	-----	5.40	.17	62.83	.8848	25.0	-----	
105	9.86	.48	-----	6.80	.20	63.26	.8911	25.5	-----	
107	8.52	1.41	4.77	4.43	.55	59.11	.8808	24.0	-----	None.
108	8.53	1.36	5.95	5.17	.42	52.80	.8835	23.0	9.599	Considerable.
110	7.37	1.16	-----	6.18	.35	63.12	.8834	24.5	-----	Do.
112	6.86	1.77	-----	3.72	.42	58.57	.8914	22.5	-----	None.
113	9.47	1.33	5.67	5.31	.35	66.50	.8828	25.0	9.795	Considerable.
115	9.00	1.66	3.68	3.68	.30	66.59	.8874	22.5	9.649	Do.
118	9.15	1.43	6.21	6.69	.22	60.53	.8891	25.0	9.607	None.
119	9.25	.77	4.00	4.04	.26	53.37	.8876	26.5	9.574	Do.
120	9.87	2.64	5.70	5.22	.82	58.12	.8818	25.5	9.613	
121	9.23	1.52	3.68	3.80	.35	61.80	.8880	22.5	9.670	None.
124	9.37	1.63	5.42	5.82	.22	64.66	.8898	23.5	9.615	Do.

BUTTERS.

125	8.32	1.27	3.64	3.81	11.10	37.75	.8925	35.5	9.327	None
126	11.43	1.83	4.98	4.05	8.55	36.86	.8979	36.1	9.362	
127	12.98	1.30	3.94	4.04	10.82	41.20	.8984	35.5	-----	

As will be seen at a glance, the melting points of the oleomargarines are low. The samples were purchased in the spring; some contained considerable cotton-seed oil, and were evidently made for the winter trade. A product intended for summer use would contain more stearin. The minute quantity of volatile acids shows the presence of only a trace of butter, or its entire absence, while the high iodine absorption shows the presence of considerable cotton-seed oil or lard.

The figures in some of the samples for albuminoids show an unusually high percentage. This points to a contamination with animal fiber and indicates that the material used was not pure.